

SECTION IV.—RIVERS AND FLOODS.

RIVERS AND FLOODS, DECEMBER, 1914.

By ALFRED J. HENRY, Professor of Meteorology in charge of River and Flood Division.

[Dated Washington, D. C., Jan. 25, 1915.]

Texas.—Heavy local rains in the watersheds of the Guadalupe, middle Colorado, lower Brazos, and lower Trinity on the 1st caused the Trinity at Dallas to overflow its banks on the 3d, the Guadalupe to reach the flood stage at Victoria on the 4th, and the Colorado to attain a bank-full stage on the 2d. These freshets subsided quickly.

The rains continued intermittently until the morning of the 3d, but they were light as a rule.

Carolinas, Georgia, and Tennessee.—The same storm caused quite general rains in the Carolinas, Georgia, and Tennessee on the 4th and 5th, ceasing on the last-named date. These rains caused the rapidly flowing streams of the foothills country in the Carolinas to reach and pass slightly above flood stages. A second short period of general rains occurred over Tennessee and the Carolinas on the 25th, and finally, on the 29th, another period of general, but not especially heavy, rains occurred. The rivers of South Carolina were in flood on the 26th and 27th and those of North Carolina about a day later, the details being shown in the table below. A portion of the Tennessee River in the Chattanooga district barely reached the flood stage on the 28th. There was no financial loss.

TABLE 1.—Flood crest stages in Carolina rivers during December, 1914.

River.	Station.	Flood stage.	Crest stage.	Date.
<i>North Carolina.</i>				
		<i>Feet.</i>	<i>Feet.</i>	
Roanoke.....	Weldon.....	30.0	33.0	Dec. 8
Neuse.....	Smithfield.....	13.0	17.8	Dec. 28
Cape Fear.....	Fayetteville.....	35.0	41.0	Dec. 27
Tar.....	Greenville.....	13.0	13.5	Jan. 1
<i>South Carolina.</i>				
Saluda.....	Pelzer.....	7.0	8.6	Dec. 5
Do.....	do.....	7.0	7.6	Dec. 26
Do.....	Chappels.....	14.0	14.0	Dec. 7
Do.....	do.....	14.0	14.0	Dec. 28
Broad.....	Blairs.....	14.0	15.9	Dec. 14
Do.....	do.....	14.0	16.9	Dec. 27
Congaree.....	Columbia.....	14.0	15.5	Dec. 3
Do.....	do.....	14.0	16.1	Dec. 27
Catawba.....	Catawba.....	11.0	17.0	Dec. 6
Do.....	do.....	11.0	16.2	Dec. 27
Wateree.....	Camden.....	24.0	29.5	Dec. 4
Do.....	do.....	24.0	30.5	Dec. 27
Great Pee Dee.....	Cheraw.....	27.0	29.4	Dec. 7
Do.....	do.....	27.0	33.2	Dec. 27

TABLE 2.—Money loss due to floods in the Carolinas, December, 1914.

Items.	North Carolina.	South Carolina.
Bridges, highways, etc.....		\$2,650.00
Crops.....		600.00
Live stock.....		1,790.00
Suspension of business.....	\$5,000.00	555.00
Total money loss.....	5,000.00	5,595.00
Total lives lost.....		4
Estimated saving by warnings.....	10,000.00	35,400.00

Arizona.—A 3-days rainfall over southern Arizona on the 22d to 24th filled all streams and dry channels of that region to overflowing. The resulting damage, after making allowance for the usual exaggeration of newspaper reports, was undoubtedly heavy. The greatest destruction appears to have been done in the Santa Cruz River Valley, south of Tucson. That river, which terminates in the desert near Tucson, is said to have attained a width of more than a mile and a half in places south of Tucson. The mountainous nature of the basin of the upper Santa Cruz and the San Pedro Rivers added greatly to the suddenness of the flood both in rising and decaying. The flood in the Gila at Florence, the only gaging station on the river, continued over several days. The report from that station for the several dates during the continuation of the flood follows. The flood stage is 3 feet.

Date.	Hour.	Stage.	Above flood stage.	Remarks.
		<i>Feet.</i>	<i>Feet.</i>	
Dec. 18.....		4.0	1	
19.....	9:30 a. m.	4.0	1	
19.....	6:00 p. m.	6.0	3	
20.....	8:45 a. m.	8.0	5	
20.....	4:00 p. m.	10.0	7	
23.....	5:00 p. m.	9.6	6.3	
24.....	8:00 a. m.			Approach to bridge washed away. No reading.
25.....	9:00 a. m.	7.6	4.6	

Hydrographs for typical points on several principal rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.

SNOWFALL AT HIGH ALTITUDES, DECEMBER, 1914.

Arizona.—While the greater part of the precipitation for December occurred in the form of rain throughout the mountain districts of the southern half of the State, except in the most elevated regions, more than the average amount of snowfall was reported from most sections, owing to the unusually stormy conditions. Notwithstanding the rains and considerable melting, an average depth or more of snow with a high water content was generally reported from the mountain districts at the close of the month.

In the Salt River Watershed, reports from the White Mountain districts, the northern slopes of the Blue Range, and from the northern divide were more promising than usual, so early in the season, for an adequate spring run-off to the Roosevelt Reservoir. At the end of the month there were from 8 to 12 inches of snow at the higher elevations on the northerly slopes, with the snow line extending approximately to the 6,000-foot level.

In the southeastern counties the snowfall was heavy in the mountains, but there was much melting, leaving but an average amount in the Huachuca and the Chiri-

cahua Ranges at the close of the month. Less than the average was reported from the Pinal Mountains, while the amount at the higher levels of the Graham Mountains was unprecedented for December.

As usual, there was no snow of importance remaining in the Bradshaw Mountains, and only the average covering appeared on the higher peaks of the Verde Valley. In the Mogollon Mountains on the northerly slopes from 6 to 18 inches was reported, the snow line extending to the 6,000-foot level, with drifts and shaded patches as low as 5,000 feet.

To the northward, at the end of December, there was somewhat more than a foot of snow on Bill Williams Mountain, from 2 to 3 feet on the San Francisco Peaks, and more than the usual amount over the northern plateaus, above the 7,000-foot level.—*Robert R. Briggs, Section Director.*

California.—The snowfall during the month was slightly in excess of the average and was well distributed throughout the mountain regions of the State. The snow on the ground is generally well packed and contains a good amount of water. There is very little snow below the 3,000-foot level.—*George H. Willson, District Forecaster.*

Colorado.—December was not so dry as November, and there has been an increase in the amount of snow in the mountains, despite the large number of bright, sunny days. The average depth on the ground, however, is still small; in fact, the least for the end of December in five years on all watersheds except the Rio Grande and San Juan. While conditions on these two watersheds have been relatively more favorable than on the western and eastern watersheds, the amount of snow is less than usual.

The average water content of the snow on the ground at the end of December was as follows: South Platte, 0.40 inch; North Platte, 0.51 inch; Arkansas, 0.65 inch; Rio Grande, 1.10 inch; Grand, 0.63 inch; Gunnison, 1.26 inches; Yampa and White, 0.76 inch; and San Juan, 1.80 inches.—*F. H. Brandenburg, District Forecaster.*

Idaho.—Following an abnormally dry November, December was the driest month of the name since State-wide records were begun in 1892. The snowfall at mountain stations ranged from 3 to 20 inches. There were few extremely low temperatures, but the month was persistently cold, the mean temperature having been next to the lowest on record. The snow, having fallen during the prevalence of low temperature, was light, and possessed an unusually small water content. The snow was drifted very little, and the soil was frozen to an unusual depth. In all parts of the State except the Panhandle the snow supply at the close of the month was much below normal.—*Edward L. Wells, Section Director.*

Montana.—November and December, 1914, like the corresponding months of 1913, were deficient in precipitation, and there was a corresponding deficiency in the amount of snow accumulated in the high mountain regions. October was a wet month, and several feet of snow fell at high altitudes in the main range and most of the high ranges to the east of this. In the valleys and foothills the October precipitation was mostly rain, or moist snow, which soon melted, and the bulk of the moisture was taken up by the soil, while at elevations above 7,000 feet this early fall of snow has become very hard and icy as the result of warm days and freezing nights. The greater portion of the snow remaining in the mountains fell during the October storm.

The ground is generally bare below 6,000 feet elevation, and at no time have the ranges been covered to a sufficient depth to seriously interfere with the grazing of stock.—*R. Frank Young, Section Director.*

Nevada.—The depth of snow at the close of the month was generally less than on December 31, 1913. Prof. J. E. Church, jr., of the University of Nevada, reports that the snow on Mount Rose was about 10 inches deep at the 6,000-foot level, 20 inches at the 8,000-foot level, and 30 inches at the 9,000-foot level. The density of the snow was approximately 19 per cent. The average depth south of Mount Rose and north of Lake Tahoe, was about 24 inches.

Mr. A. L. Smith, the observer of the university at Tahoe, Cal., reports that the depth of snow on the ground December 30, 1914, was 13 inches, as against 26 inches on the corresponding date in 1913.

Lake Tahoe was at a stage of 7.13 feet, as against a stage of 4.60 feet at the close of December, 1913.—*Henry F. Alcatorre, Section Director.*

Oregon.—The amount of snow in the Oregon mountains at the end of December was much less than usual. Weather was cold with east winds prevailing for more than half of the month. These winds are dry winds, and the little snow that fell has drifted considerably, but it is not well packed. So far a shortage of irrigation water is indicated, but this shortage could easily be overcome during the remainder of the season.—*Edward A. Beals, District Forecaster.*

New Mexico.—December was a cold, cloudy, stormy month, with heavy snowfall over practically the entire State, except the lowest southern valleys. The average fall for the State was 10.6 inches, not quite so great as December, 1913, but southern counties, especially southwestern, had heavy rains, bringing the average precipitation for the month far above December, 1913.

The accumulated depth at the close of the year averaged 10 to 12 inches over the highest parts of the main range at the headwaters of the Canadian. The headwaters of the Pecos were better favored, but even there the stored depth was small. A like condition prevailed over the Capitan, White, and Sacramento Mountains of the southeast, and the Black in the southwest. While over the headwaters of the Rio Grande, San Juan, and northwest a depth of 15 to 30 inches was reported. The soil of the State was well filled with moisture, and conditions thus far appear favorable.—*Charles E. Linney, Section Director.*

Utah.—Snow in the hills and mountains, and, in fact, in all the valleys of Utah, was lighter at the end of December, 1914, than for many years. The deepest snow reported was 18 inches near Manti, Sanpete County. Every correspondent reported snow below the average depth for this time last year, and that from the December indication the water supply will be below normal. The snow, as a rule, was neither drifted nor packed.—*Alfred H. Thiessen, Section Director.*

Wyoming.—The amount of snow in the mountains and in the forests of Wyoming at the close of November was inappreciable. At the end of December, while amounts had increased substantially, observers at all stations reported less than normal. Owing to the low temperature, little was wasted by melting and little by the wind, which was light. The most favorable conditions appear on the watersheds of the Green, North Platte, and Snake Rivers; the least favorable on those of the Tongue and Powder Rivers, where amounts are far below normal.

A depth of 22 inches is the greatest reported on the North Platte watershed, 24 inches on the Snake River,

and 25 inches on the Gallatin River watershed. Amounts in Yellowstone Park vary greatly on the different watersheds and as to exposure.

As might be expected, the water equivalent of the snow where deepest and well settled is greater than where the covering is light.—*R. Q. Grant, Section Director.*

MEAN LAKE LEVELS DURING DECEMBER, 1914.

By UNITED STATES LAKE SURVEY.

[Dated Detroit, Mich., Jan. 4, 1915.]

The following data are reported in the "Notice to Mariners" of the above date:

Data.	Lakes.			
	Superior.	Michigan and Huron.	Erie.	Ontario.
Mean level during December, 1914:				
Above mean sea level at New York.....	Feet. 602.08	Feet. 579.62	Feet. 571.31	Feet. 244.83
Above or below—				
Mean stage of November, 1914.....	-0.37	-0.30	-0.13	-0.42
Mean stage of December, 1913.....	-0.62	-0.72	-0.33	-1.08
Average stage for December, last 10 years.....	-0.23	-0.61	-0.45	-0.77
Highest recorded December stage.....	-1.05	-2.30	-2.22	-2.78
Lowest recorded December stage.....	+0.88	+0.62	+0.45	+1.40
Probable change during January, 1915.....	-0.3	-0.2	0.0	+0.1

FLOODS IN NEW ENGLAND RIVERS.

By ALFRED J. HENRY, Professor of Meteorology.

[Dated, Weather Bureau, Washington, D. C., January —, 1915.]

Floods in New England are due almost wholly to the breaking up of ice and the melting of snow on the head-water streams. When this annual event occurs in conjunction with heavy and prolonged rains the ordinary spring freshet becomes a damaging flood. The occurrence of heavy rains over New England is more or less fortuitous; hence the number of destructive floods is not great.

Thanks to the industry of Mr. W. W. Neifert, official in charge of the Hartford, Conn., Weather Bureau station, it is possible to present here a table of flood crests at Hartford extending back to the middle of the nineteenth century; also a statement of the maximum stages in the Connecticut at Springfield and Holyoke, Mass., extending back to 1870. The records of the earlier years, 1850–1870, are from the annual reports of the Chief of Engineers, etc., and the second source of information is the records of the Essex Company of Lawrence, Mass., as published in House Document No. 9, Sixty-second Congress, first session.

Only floods of considerable magnitude are included in this table. The present flood stage in the Connecticut at Hartford is taken as 16 feet above the zero of the local gage, and the highest stage ever recorded is 19.8 feet. It is therefore assumed that a 20-foot stage at Hartford corresponds to a serious flood there. A 20-foot stage in the Merrimac at Lawrence, Mass., causes inconvenience but no serious damage if the mills are warned of the approaching flood. These stages have been the criteria for selecting the floods listed in Table 1. If the gage height at either station was 20 feet or more it is considered and entered as a flood and the corresponding gage heights at the other stations are given, although they may not have been as much as 20 feet. This explains the appearance of stages less than 20 feet in the table at both Lawrence and Hartford. The times of the maximum stages at Holyoke and Springfield generally

harmonize with those for Hartford. When this is not the case it is manifest that the flood recorded at the lower station was not general in the middle and upper reaches of the river.

TABLE 1.—Chronological list of floods in New England, 1850–1913.

Year.	Merrimac River.		Connecticut River.					
	Lawrence, Mass.		Hartford, Conn.		Springfield, Mass.		Holyoke, Mass.	
	Stage.	Date.	Stage.	Date.	Stage.	Date.	Stage.	Date.
	Feet.		Feet.		Feet.		Feet.	
1850.....	22.7	May 1	20.0	May —			9.6	
1852.....	28.9	Apr. 23	23.2	Apr. 24				
1853.....			20.5	Nov. —				
1854.....	22.3	May 2	29.8	May 1	22.2			
1856.....	15.1	Aug. 23	23.3	Aug. 22				
1857.....	21.5	Apr. 16	19.5	Feb. 21				
1857.....	17.6	Oct. 28	18.2	Oct. 28				
1859.....	24.1	Mar. 21	26.4	Mar. 19				
1861.....	20.2	Apr. 16	21.5	Apr. 17				
1862.....	24.2	Apr. 21	28.7	Apr. 21	22.0	Apr. —		
1863.....	21.1	Apr. 20	22.2	Apr. 20				
1864.....	23.0	Mar. 8	17.2	Apr. 20				
1865.....	23.0	Mar. 18	24.8	Mar. 20				
1866.....	15.6	Feb. 15	20.5	Feb. 26				
1867.....	18.7	Apr. 19	17.2	Feb. 17				
1868.....	16.4	Mar. 20	21.5	Mar. 19				
1868.....	20.2	May 25	20.0	May 23				
1869.....	21.4	Apr. 23	28.7	Apr. 23				
1869.....	24.5	Oct. 6	26.3	Oct. 6	20.5	Oct. —		
1870.....	21.7	Jan. 4	19.2	Jan. 4				
1870.....	20.0	Feb. 21	21.3	Feb. 20				
1870.....	27.8	Apr. 21	25.3	Apr. 21				
1871.....	16.9	Mar. 14	16.5	Mar. 13				
1871.....	16.6	May 8	18.7	May 7	13.0	May 6		
1872.....	19.3	Apr. 12	21.0	Apr. 13	14.2	Apr. 12		
1873.....	18.8	—	21.2	—	15.0	—		
1874.....	20.8	Jan. 10	23.9	Jan. 9	17.5	Jan. 9	8.0	Jan. 9
1875.....	21.0	Apr. 6	18.4	Apr. 8	15.0	Apr. 5	6.0	Apr. 5
1876.....	20.6	Mar. 20	22.0	Apr. 16	17.0	Apr. 16	9.2	Apr. 16
1877.....	23.4	Mar. 29	22.9	Mar. 29	16.5	Mar. 29	8.8	Mar. 29
1878.....	21.0	May 1	18.5	Apr. 30				
1878.....	25.2	Dec. 12	24.5	Dec. 13	18.5	Dec. 11	9.2	Dec. 11
1879.....	17.8	May 3	21.5	May 1	15.8	May 1	8.5	May 1
1880.....	14.8	Apr. 6	15.4	Apr. 7	10.8	Apr. 6	5.7	Mar. 7
1881.....	15.4	Mar. 12	16.5	Apr. 26	11.5	Apr. 26	7.3	Dec. 31
1882.....	17.2	Mar. 4	14.8	May 31	10.9	Mar. 3	8.1	Sept. 24
1883.....	16.6	Apr. 14	20.5	Pr. 15	14.6	Apr. 14	7.1	Apr. 15
1884.....	21.8	Mar. 29	21.6	Mar. 28	16.0	Mar. 28	7.2	Mar. 28
1884.....	20.1	Apr. 19						
1885.....	13.7	Apr. 6	18.0	Apr. 24	13.3	Apr. 24		
1885.....	13.8	Nov. 11	16.8	Nov. 8			6.9	Nov. 10
1886.....	21.7	Feb. 15	18.4	Jan. 7	16.0	Apr. 2	7.9	Apr. 2
1886.....			21.8	May 4				
1887.....	17.8	Jan. 31	22.5	Apr. 13	17.0	Apr. 13	8.2	Apr. 13
1888.....	19.5	May 1	19.4	Apr. 8	17.7	May 1	8.9	May 1
1888.....			21.8	May 4				
1889.....	14.4	Nov. 30	15.6	Nov. 30	11.3	Nov. 29	5.0	Nov. 29
1890.....	14.6	Apr. 17	15.2	May 9	11.7	Oct. 21	5.8	Sept. 18
1890.....	17.1	Oct. 21	16.0	Oct. 26				
1891.....	20.2	Mar. 25	17.5	Jan. 24	14.2	Apr. 17	6.7	Apr. 19
1892.....	15.5	May 24	18.3	June 16	13.7	June 16	6.5	June 15
1893.....	21.3	May 6	24.0	May 6	18.1	May 5	8.4	May 5
1894.....	14.8	Mar. 9	13.8	Apr. 25	10.4	Apr. 26	4.8	Apr. 25
1895.....	26.9	Apr. 16	25.7	Apr. 16	20.2	Apr. 17	9.6	Apr. 17
1896.....	29.7	Mar. 3	26.5	Mar. 3	20.2	Mar. 3	9.5	Mar. 2
1897.....	14.4	Apr. 10	17.0	Apr. 10	15.2	June 12	7.0	June 11
1897.....	20.4	July 16	20.8	July 16			7.4	Dec. 16
1897.....	18.8	Dec. 17						
1898.....	18.5	Mar. 15	30.0	Mar. 16	15.5	Mar. 15	7.1	Mar. 21
1899.....	19.3	Apr. 17	22.0	Apr. 27	16.1	Apr. 27	7.4	Apr. 26
1900.....	22.5	Feb. 15	23.4	Feb. 15	17.0	Feb. 14		
1900.....	18.7	Apr. 21	22.8	Apr. 22			10.2	Apr. 21
1901.....	26.4	Apr. 9	25.8	Apr. 10	19.07	Apr. 9	11.4	Apr. 8
1901.....	17.3	Apr. 26	22.7	Apr. 23				
1902.....	24.3	Mar. 4	25.5	Mar. 4	19.2	Mar. 4	10.8	Mar. 4
1902.....	17.7	Mar. 19	19.8	Mar. 18				
1903.....	20.5	Mar. 13						
1903.....	18.8	Mar. 25	23.4	Mar. 25	17.4	Mar. 25	10.6	Mar. 24
1904.....	21.5	Apr. 30	21.4	Apr. 30				
1904.....	17.7	Mar. 28	19.5	Mar. 28	15.3	Mar. 28	9.5	Mar. 27
1905.....	20.1	Mar. 30	24.0	Apr. 2	17.5	Mar. 31	10.6	Apr. 1
1906.....	18.3	Apr. 17	19.8	Apr. 17	15.1	Apr. 17	8.9	Apr. 17
1906.....	19.5	May 30	18.5	May 30				
1907.....	15.3	Apr. 1	16.0	Apr. 1				
1907.....	18.0	Nov. 8	20.3	Nov. 9	15.4	Nov. 8	9.0	Nov. 8
1908.....			18.2	Mar. 31	13.1	Mar. 30	7.6	Mar. 30
1908.....	14.8	Feb. 17	18.5	Feb. 18				
1909.....	19.3	Apr. 16	24.7	Apr. 17	18.5	Apr. 16	10.6	Apr. 16
1910.....	16.1	Mar. 3	20.0	Jan. 23	15.0	Jan. 23	7.5	Mar. 27
1910.....			18.6	Mar. 3				
1911.....			15.5	Apr. 17	11.9	Apr. 7	7.2	Apr. 16
1911.....			16.0	Oct. 20				
1912.....	16.4	Apr. 9	21.2	Apr. 10	16.1	Apr. 9	9.3	Apr. 9
1913.....	19.6	Mar. 28	26.3	Mar. 29	20.9	Mar. 29	12.0	Mar. 28